Amendments To The Specification

Please replace paragraph [0030] on page 6 through page 7 with the following amended paragraph:

[0030] In operation, each input beam 204 is received via a suitable antenna (not shown in FIG. 2, but described more fully below). Each beam may be filtered to isolate an appropriate band of frequencies (i.e. "sub-bands" or "channels") to be amplified by a low noise amplifier (LNA) or other input amplifier 206 to improve the strength of the received signal. The amplified sub-band is then downconverted from the received frequency to a suitable intermediate frequency (IF) for digital processing. While the embodiment shown in FIG. 2 shows block down-conversions of 250-750 MHz sections of input bandwidth and switching and filtering of 24-72 MHz channels, any other frequency bands or ranges may be used in a wide array of alternate embodiments. For example, high-quality analog-to-digital converters may be used to sample incoming sub-bands at rates as high as 550 MHz or greater, thereby reducing or eliminating the need to downconvert the amplified sub-bands in many embodiments, as described more fully below. While conventional satellites most commonly use C and Ku band receive or transmit frequencies, the techniques described herein are extendable to UHF, L, S, and Ka band frequencies, as well as any other frequencies.

Please replace paragraph [0032] on page 7 through page 8 with the following amended paragraph:

[0032] The output sub-bands assembled by digital transponder unit 202 are appropriately amplified with traveling-wave tube amplifiers (TWTA), solid-state power amplifiers (SSPA) or other suitable output amplifiers 210. Although the particular output power varies from embodiment to embodiment according to such factors as the altitude above earth, transmit frequencies used, etc., typically output power of about 50W may be used at C band frequencies and about 80–120W of power may be used at Ku band. The outputs of some or all of the output amplifiers 210 may be switched, multiplexed together at output ~~mulitplexers~~ muliplexers 214, and then re-transmitted through the transmit antennas to form output beams 216. Before multiplexing, optional variable power dividers (not shown in FIG. 1) may be used to allocate power to the various coverage areas as appropriate.

Please replace paragraph [0048] on page 12 through page 13 with the following amended paragraph:

[0048] Each channel 501 suitably includes various modules for digitally processing received signals. In the exemplary embodiment shown in FIG. 5, the analog baseband signal received from the uplink antenna is first filtered and A/D converted at 502 to produce digital equivalents that can be further processed. As mentioned above, filtering and [[D/A]] A/D conversion may be handled within payload 500, or may be handled in a separate [[D/A]] A/D converter that can be located near the antenna to reduce signal noise, interference and other sources of error or distortion. The digital baseband signals may be further filtered 504 or otherwise shaped/processed to obtain a desired digital sub-band spectrum, for example. These digital signals may be demodulated at demodulation module 506 as appropriate. Demodulator 506 suitably operates at variable rates to accommodate different data types and protocols from varying data sources. The demodulated signals are then decoded, descrambled or otherwise processed 506 to a digital bitstream that can be packetized, routed and/or otherwise processed. Decoding module 508 suitably communicates with the T&C module 520, which gathers information about the data and provides [[and]] any command instructions to process the data as desired. The demodulated data can be channelized and routed from any input port to any output port on payload 400. Switch 510 therefore accommodates switching and routing of individual packets and/or circuits by mapping various slices of decoded packet data to one or more switch output ports, as described above in conjunction with FIG. 3.

Please replace paragraphs [0049] and [0050] on page 13 with the following amended paragraphs:

[0049] Additional processing of the decoded data packets may take place before, during or after routing by switch 510. Examples of the various types of processing that may be implemented include encryption/decryption, access control/authentication, data compression/extraction, protocol conversion, signal regeneration, error correction and the like.

Because the decoded data packets are simply ~~steams~~ streams of digital bits, any type of processing can be performed on the data prior to remodulation and D/A conversion. Such processing may be controlled and/or carried out by T&C module 520 and/or by other processors on any transponder card 404 or resource management cards 406 (FIG. 4).

Please replace paragraph [0052] on page 14 with the following amended paragraph:

[0052] As described above, each processing slice 406 receives sub-band spectra or other input signals from an uplink antenna. In FIG. 6, these sub-band spectra are shown as 560 MHz frequency bands provided in groups of four bands at an input port 602, although other embodiments may process different numbers of channels and/or channels of varying bandwidths. Each of the input signals are received at slice [[618]] 406, where the signals are converted to digital equivalents by ADC 604. These digital equivalents may be provided in any manner to a channelizer circuit 608. In the embodiment shown in FIG. 6, digital equivalents are provided via 8-bit parallel data connections, although alternate embodiments may use any level of bit resolution transmitted over any serial and/or parallel connection. The channelized digital bit streams are routed by various switching circuits 622 interconnected by backplane bus 620/624. As shown in FIG. 6, a UNILINK-type data bus couples the various switch ASICs 622 in a series of cascading logical rings, with data transfers occurring in a linear fashion via switch interconnections 624 and return bus 620. In alternate embodiments, the various switch ASICs 622 may be interconnected in any mesh, web, star, linear, ring or other manner. Switched frequency slices 310 are then recombined at ASICs 610 and/or digitally processed by regeneration ASICs 616 as appropriate. The recombined signals may then be D/A converted 612 and provided to the downlink antennas via output ports 614 as appropriate.

Please replace paragraph [0053] on page 14 with the following amended paragraph:

[0053] Using the structures and logical constructs shown in FIGS. 2-6, digital payloads of varying capabilities may be readily fashioned. Referring again to FIG. 2, one embodiment of digital payload [[202]] 200 provides routing and data reconstruction functionality, as well as optionally adjusting output power, providing for output linearization, adjusting output power and/or monitoring traffic and/or bandwidth utilization within payload [[202]] 200. Output linearization, for example, may be provided by pre-compensating data provided to the downlink beams for distortion observed during the downlink transmission. This pre-compensation may be programmably modified on-orbit in response to actual distortion observed, ground weather conditions, and/or other factors. Similarly, output power of the various downlink beams can be programmably adjusted upwardly or downwardly as needed to compensate for weather changes, evolving technologies, or other factors.

Please replace paragraph [0054] on page 14 through page 15 with the following amended paragraph:

[0054] With reference now to FIG. 7, a further embodiment 700 of digital payload [[202]] 200 suitably provides enhanced modular data handling capability as appropriate. Such data handling capabilities are typically processed or controlled by regeneration module 308 (FIG. 3) and/or T&C processor 520 (FIG. 5). Because the various digital frequency slices 310 (FIG. 3) can be demodulated to extract a raw bit stream, digital payload [[202]] 200 has access to the channelized signals, thereby allowing the signals to be processed and manipulated to implement additional features not readily available in the satellite environment. Examples of data handling capabilities include packet switching with additional queuing, forward error correction (e.g. using checksum, CRC, digest or other error correction techniques), code based multiplexing (e.g. code division multiple access (CDMA)), and/or enhanced security through user authentication, access authorization, data encryption and/or the like. Examples of enhanced security include network registration and/or access control using digital credentials (e.g. passwords, digital signatures or the like).

Please replace paragraphs [0055] and [0056] on page 15 with the following amended paragraphs:

[0055] In an even further embodiment, the digital signal processing capabilities of payload [[202]] 200 can be expanded to incorporate direct beam forming, essentially creating an all-digital satellite payload 800 as shown in FIG. 8. Such embodiments typically do not require downconvert or output multiplexing capabilities, since the digital payload [[202]] 200 is able to directly interoperate with phased array and/or other antennas to process uplink data and to form downlink beams ready for transmission. In such embodiments, digital payload [[202]] 200 receives the analog baseband signals from the input amplifiers 206, and provides output signals to output amplifiers 802 in analog form. Output amplifiers may be solid state power amplifiers (SSPAs) or any other suitable amplifiers. Because all of the data processing is handled digitally within payload 800, significantly enhanced capabilities such as direct point-to-point routing, transmit power and coverage optimization, anti-jamming functionality (e.g. nulling) and the like.

[0056] Nulling, for example, typically involves detecting a hostile signal at the antenna and instantly countering with a "null" signal to minimize the energy of the hostile signal as compared to friendly signals. Because digital payload [[202]] 200 is able to form individual downlink beams and to adjust the power of the output beams, nulling functionality can be directly implemented within payload [[202]] 200 by creating a desired downlink signal that can be directed at the hostile source. Moreover, hostile signals can be digitally extracted from uplink signals received, and/or access restrictions can be used to further secure data transmissions within payload [[202]] 200.

Please replace paragraphs [0058] and [0059] on page 16 with the following amended paragraphs:

[0058] Because various payload resources (bandwidth, power, etc.) can be readily monitored and adjusted on-orbit in real time within digital payload [[202]] 200, for example, new techniques for exploiting the payload resources are enabled. As mentioned above, bandwidth and other resources may be monitored (e.g. by telemetry and command module 520 in FIG. 5 or the like) to re-assign excess resources to other beams, channels or slices having a need for such resources.

[0059] With reference now to FIG. 9, an exemplary process 900 for re-allocating resources within the payload [[202]] 200 suitably includes the broad steps of defining an initial allocation (step 902), monitoring resource usage (step 904), and adjusting resource allocation upwardly (steps 906 and 908) or downwardly (steps 910) as needed. While FIG. 9 refers to bandwidth as the particular resource being allocated, various equivalent embodiments will allocate other resources such as electrical power, antenna coverage and the like.

Please replace paragraph [0062] on page 17 with the following amended paragraph:

[0062] Another process 1000 enabled by the flexible satellite architecture is shown in the data flow diagram of FIG. 10. Process 1000 allows various parties to independently control a portion of the satellite resources to thereby allocate the resources as desired. With reference now to FIG. 10, a block of satellite resources 1002 is divided and assigned amongst one or more resource managers 1006A-C who are responsible for sub-assigning the resource to various entities 1008A-C operating within the manager's domain. Although not shown in FIG. 10, the sub-entities may further sub-assign the resource to still other entities (or multiple sub-levels of entities) in alternate embodiments. Managers 1006 may be battlefield commanders, for example, who assign satellite bandwidth dynamically among units within their control. If a unit is assigned a fixed amount of bandwidth, for example, a commander may temporarily assign a large portion of bandwidth to one unit (e.g. an unmanned aerial vehicle with a camera) for a short period of time to allow transmission of visual images, large data files or the like. After the need for the bandwidth subsides, that bandwidth may be re-allocated to other units for enhanced voice, data or other traffic. Such flexibility may be particularly useful for network centric operations (NCO) and other military purposes, although the general concept could be used in corporate, industrial, entertainment or other governmental settings as well. Access control could be enforced within digital payload [[202]] 200 (FIGS. 2-8) by assigning digital credentials (e.g. cryptographic certificates or the like) to the various managers 1006 and other entities 1008 and associating the various certificates with an access table or other data structure within payload 202 (e.g. within T&C module 520 or the like). Numerous other allocation plans and techniques could be formulated in a wide array of equivalent embodiments.

Please replace paragraph [0063] on page 17 through page 18 with the following amended paragraph:

[0063] In various further embodiments (and with reference now to FIG. 11), digital payload [[202]] 200 can be combined with multi-beam phased array or similar antennas capable of projecting multiple spot beams to further enhance the flexibility of satellite 1100. In such embodiments, sub-frequency bands can be re-used on the multiple downlink spot beams 1106, thereby improving bandwidth efficiency. One or more broadcast beams 1104 may also be provided. These spot beams may be narrowly tailored and focused to provide bandwidth solely in desired areas, and may also facilitate frequency hopping techniques that further enhance security.